Scientists on a Roll With Wheat Protein Studies

PEGGY GREB (K11539-1)

A wheat grain is made up mostly of starchy endosperm. In this close-up, the extruded endosperm appears as a whitish mass at the tip of the grain in the center of the head.

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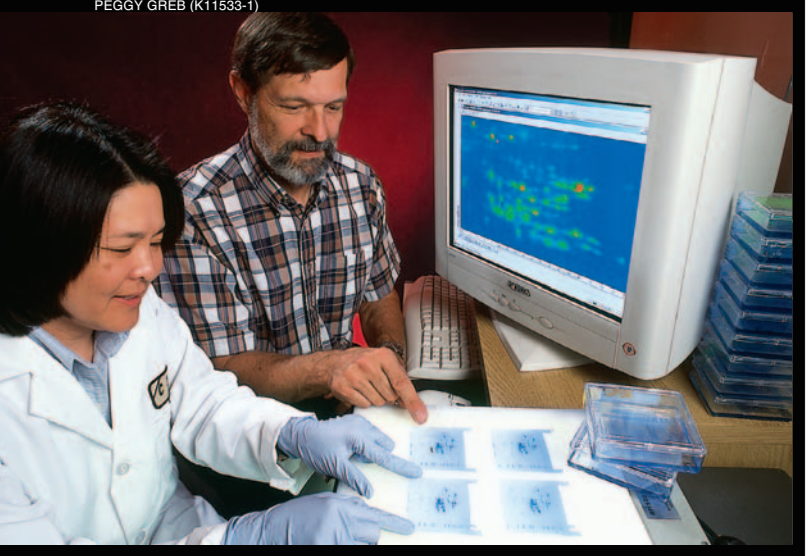

Using two-dimensional gel electrophoresis and sophisticated computer software, plant physiologists Charlene Tanaka and Bill Hurkman compare protein patterns in wheat endosperm during grain development.

Whether it's a fragrant slice of freshly baked artisan bread or a perfectly prepared pasta entree, most of us eat foods made from wheat flour every day. The quality of that flour is due, in large part, to the work of hundreds of different proteins that perform specialized tasks inside the wheat kernel, or grain.

Discovering more about the work of these proteins—and how they're affected by the heat, soil nutrients, and other environmental conditions in which the plant is grown—might lead to even better flours for tomorrow. A top-quality flour can make a bread or a pasta remarkable instead of just ordinary.

Gluten proteins are the most abundant and most studied. Researchers already know that these proteins have a premier role in influencing a flour's quality.

In contrast, scientists know very little about wheat kernels' so-called metabolic proteins, which occur in much smaller amounts. It is known, however, that these mostly mysterious proteins are essential to a kernel's growth. For example, wheat plants need metabolic proteins to form the gluten proteins and to make starch. Gluten and starch are the main components of flour.

Protein Profilers Sleuth Metabolic Proteins

In Albany, California, ARS plant physiologist William J. Hurkman is working with Charlene K. Tanaka, also a plant physiologist, and chemist William H. Vensel to uncover more details about the biochemical chores carried out by these less-abundant wheat proteins. The scientists are in the ARS Western Regional Research Center's Crop Improvement and Utilization Research Unit.

Working with kernels from wheat plants grown in their research greenhouses, the scientists separated metabolic proteins from one another with a laboratory technique called two-dimensional gel electrophoresis.

Another technology, mass spectrometry, gave them a distinct profile of each protein. Using computers, they matched many of these protein profiles to those in other plants. They located those other profiles by searching research databases posted on the World Wide Web. With this approach, the researchers

identified more than 200 wheat kernel proteins and grouped them by the tasks they likely perform, ranging from storing carbohydrates to protecting the kernel against insects.

The researchers also tested kernels, from the greenhouse plants, in two different growth stages. They found changes, over time, in the relative abundance of proteins. For example, certain metabolic proteins were more abundant in the early days of kernel growth than in the final weeks. This chronology of proteins at work inside wheat kernels is the kind of detail that could lead to improved flours.

PEGGY GREB (K11543-1)

Plant physiologist Bill Hurkman harvests a wheat head from plants grown in a climate-controlled greenhouse at ARS's Western Regional Research Center.

A Catalog of Kernel Proteins

The analysis of hundreds of wheat-kernel proteins is what's newly described as "proteomics," the comprehensive study of the function, structure, and location of proteins. The catalog of proteins in wheat kernels that the scientists are compiling is a proteome, just as a genome is a directory of all genetic material in a plant or animal.

Similar work has been done at other labs to identify proteins and their functions in wheat, barley, and alfalfa grains, for instance. But the California investigators are likely the first to delve this deeply into the roles and changing ratios of the lesser-known wheat-kernel proteins.

The ARS research led to new collaborations with University of California at Berkeley researcher Bob B. Buchanan and colleagues to learn more about other aspects of wheat proteins.

Tracking Proteins to Their Gene Origins

As part of uncovering even more pieces of the wheat protein puzzle, scientists are tracking the proteins' gene origins, as well as how proteins affect flours.

Whether metabolic or gluten, all wheat proteins are the product of genes. Susan B. Altenbach, a biologist with the ARS group, is studying genes that cue the wheat plant to make kernel proteins. To do this, she's using a technique called microarray analysis. This leading-edge technology makes it possible to study thousands of wheat genes, conveniently positioned on a single, 1-by-3-inch glass slide.

Analyzing kernel proteins in their end product—wheat flour itself—is another tactic that's revealing more about them. Plant physiologist Frances M. DuPont of the Albany team has shown that the amounts of heat and fertilizer greenhouse wheat plants were exposed to affected levels of certain kernel proteins. One outcome: lower-quality flour, resulting in doughs that were unable to withstand the rigorous mixing that's part of making bread.

The experiments highlight the importance of pinpointing kernel proteins' precise roles and using what's discovered to breed better wheat plants for the future. The superior flours these plants produce should please not only growers and millers, but also the people working in commercial or home kitchens to prepare delicious, wheat-flour-based foods for us.—By **Marcia Wood,** ARS.

This research is part of Plant Biological and Molecular Processes (#302) and Quality and Utilization of Agricultural Products (#306), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

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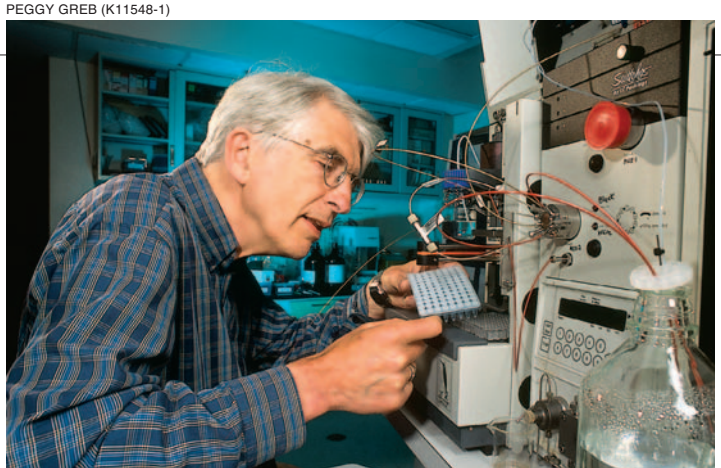

Chemist William Vensel loads a plate of wheat endosperm protein digests into an autosampler for protein analysis.